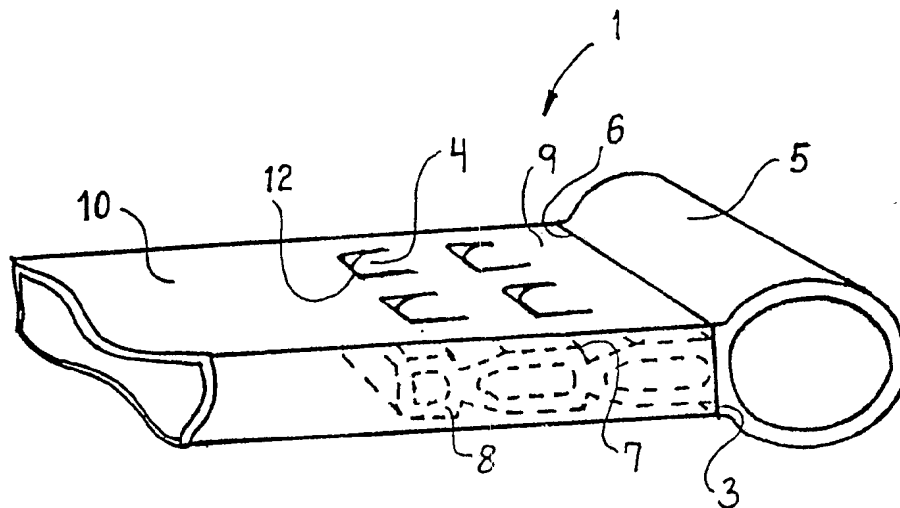




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COÖPERATION TREATY (PCT)

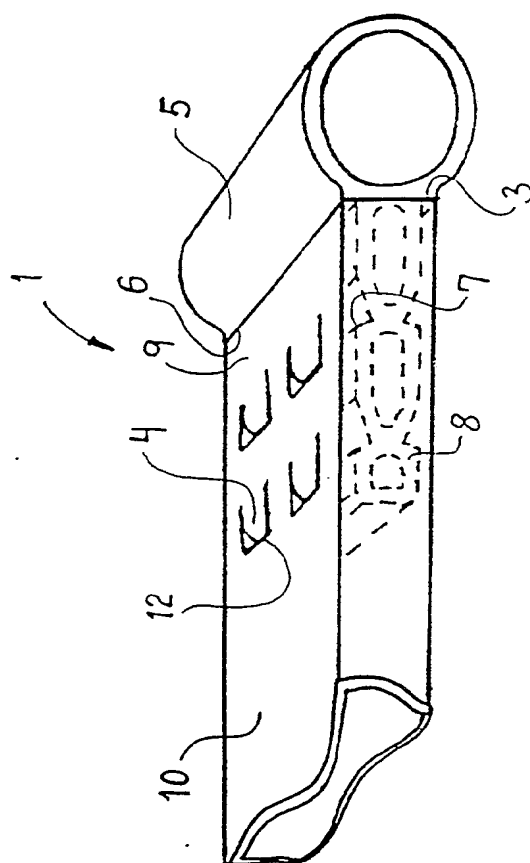
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<b>(21) International Application Number:</b> PCT/NO91/00050 <b>(22) International Filing Date:</b> 26 March 1991 (26.03.91)  <b>(30) Priority data:</b> 901462                      30 March 1990 (30.03.90)                      NO  <b>(71) Applicant (for all designated States except US):</b> RAUFOSS A/S [NO/NO]; N-2830 Raufoss (NO).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only) :</b> HEGGEN, Hans [NO/NO]; N-2770 Jaren (NO). NYBORG, Kjell [NO/NO]; N-2864 Fall (NO). STRANDE, Lars [NO/NO]; N-2762 Røykenvik (NO).  <b>(74) Agent:</b> BYKLUM, Knut, B.; Bryns Patentkontor A/S, Postboks 9566, Egertorget, N-0128 Oslo 1 (NO).		<b>(81) Designated States:</b> AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Norwegian).</i>

**(54) Title:** JOINING STRUCTURAL ELEMENTS**(57) Abstract**

A method and a joint (1) for joining structural elements (5, 10) of a plastic deformable material, e.g. aluminium, is disclosed. One structural element (5) has a male portion (8) for insertion into a female portion (9) of the other structural element (10). One structural element has at least one engaging surface (6) and at least one reaction surface (7), and the other structural element (10) has at least one engaging surface (3) for contact with said engaging surface (6) of the first mentioned structural element and at least one punched or recessed member (4) with a reaction surface (12) for wedging cooperation with reaction surface(s) (7), said elements (5, 10) being locked in a fixed, clamped state.

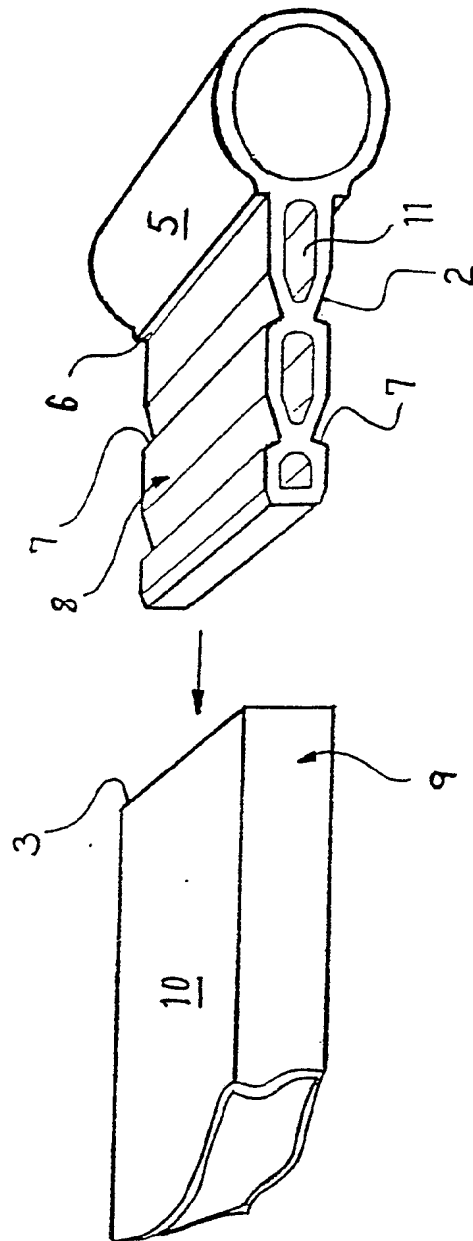
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FIG. 1



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FIG. 2



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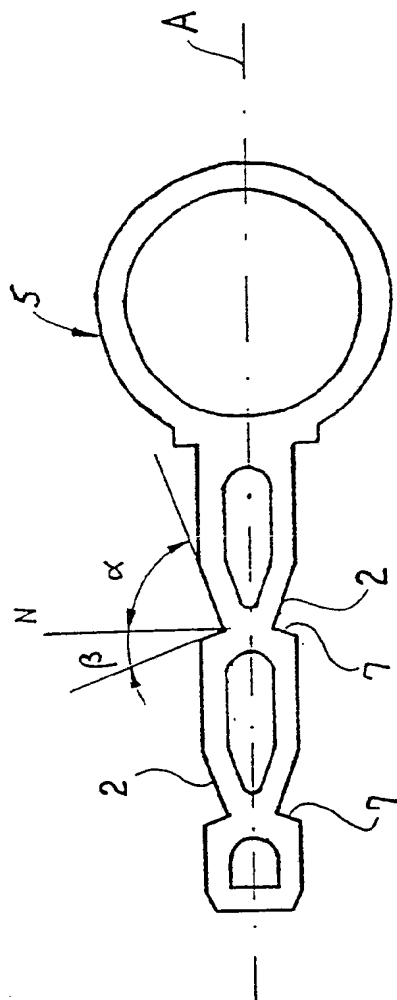


FIG. 3

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FIG. 4

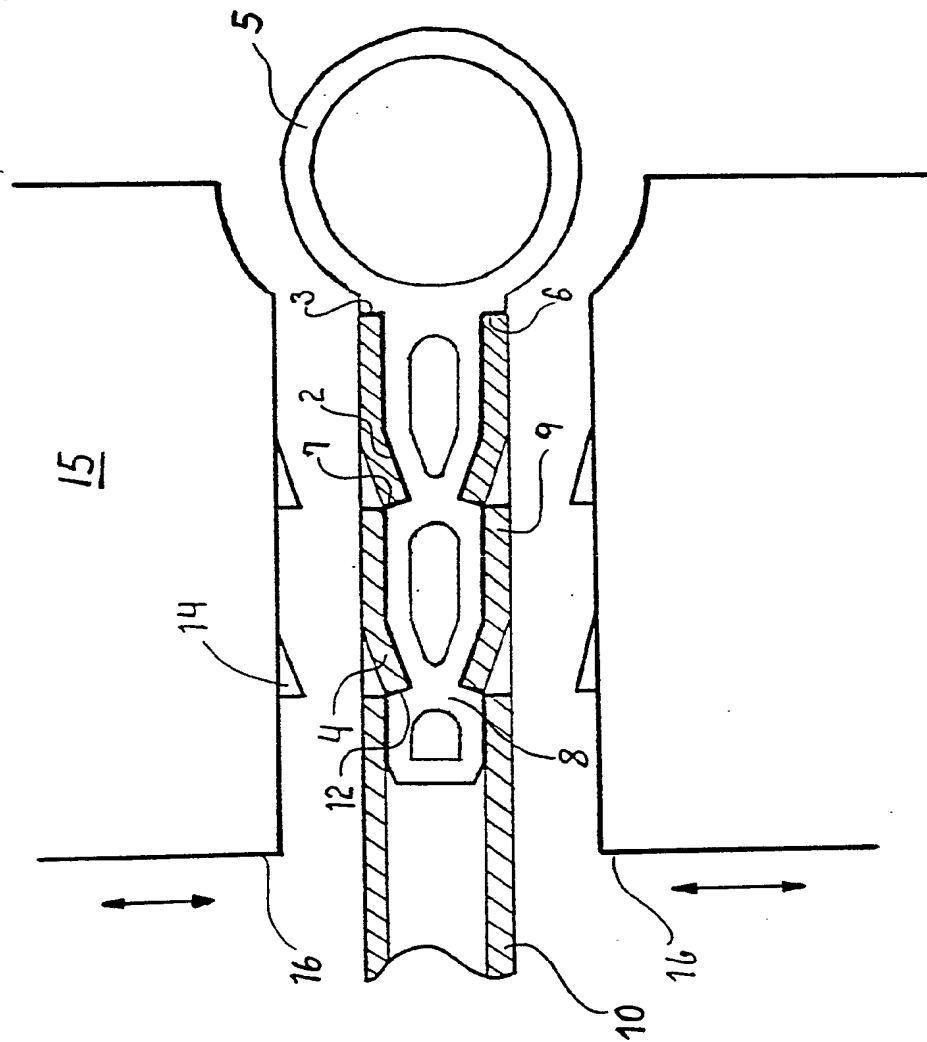


FIG. 5

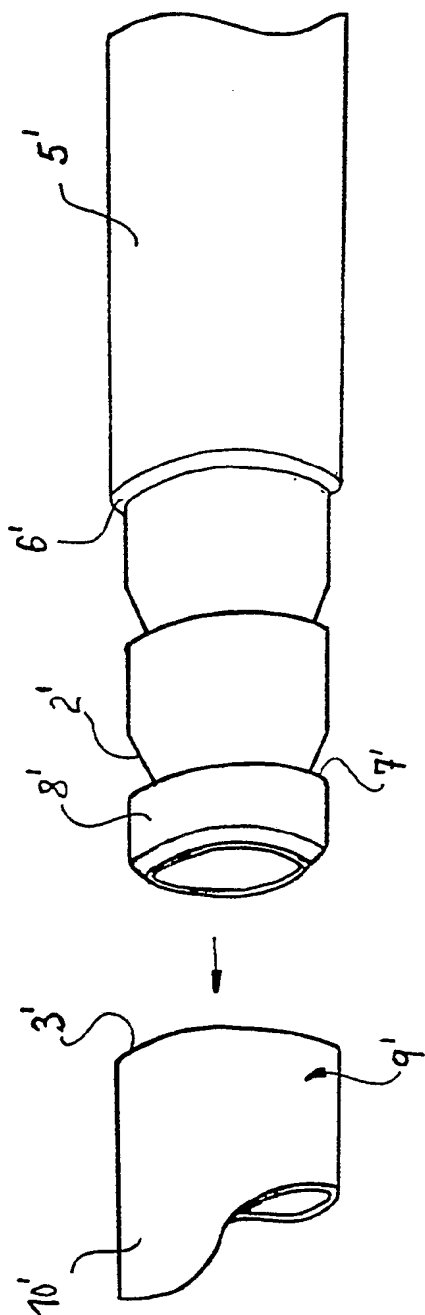
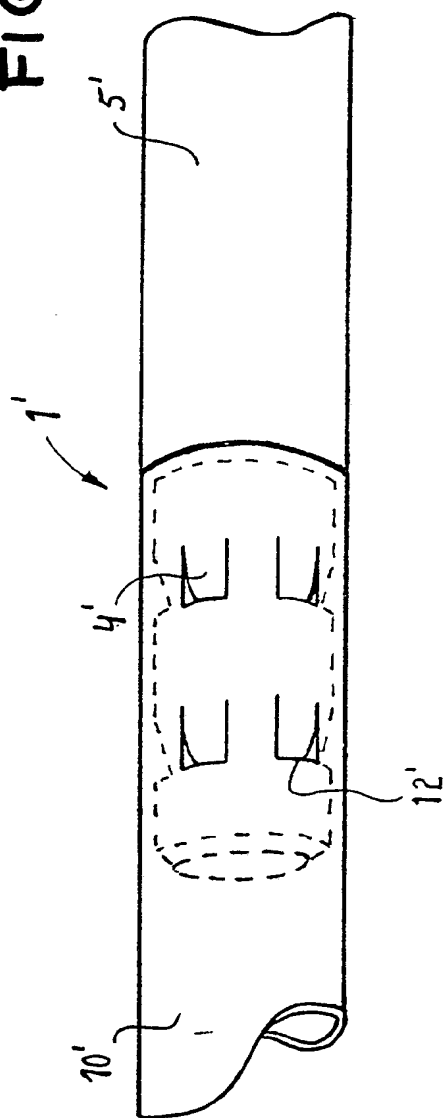


FIG. 6



JOINING STRUCTURAL ELEMENTS

The present invention relates to a method and a joint for joining structural elements of a plastic deformable material, e.g. aluminium, with one of the structural elements having a male portion for insertion to engagement in a female portion of the other structural element.

The invention was especially developed for joining extruded aluminium profiles, but it may obviously be used generally for joining structural elements which are made from a plastic deformable material. Even though the invention finds special application for extruded profiles, the invention may also be used for profiles which are not extruded. The invention may be used for joining structural elements, e.g. for building scaffolding, banisters, framework, trusswork, etc.

Structures like scaffolding of aluminium with welded joints have proved to have a tendency to crack due to fatigue when used for some length of time. Welded connections will often be undesirable from an aesthetic point of view, and welding operations being time consuming they are also undesirable as regards costs.

It is an object of the invention to avoid welded connections of structural elements and to replace such connections by joints which are not subjected to fatigue, are aesthetically attractive and permit the joining operation proper to be performed rapidly.

According to the invention this is achieved by a method of the above mentioned kind, according to which joining occurs by the aid of a punching press means, and which is characterized by the fact that the female portion is partly cut through into discrete areas to form partly cut out recessed

members, said recessed members concurrently being upset and pressed with a wedging effect towards at least one reaction surface on the male portion.

5 Thus a joint of the above mentioned kind is provided, which is characterized by the fact that one of the structural elements has at least one engaging surface and at least one reaction surface, and that the second structural element has at least one engaging surface for engagement with the  
10 engaging surface of the first structural element, and at least one recessed member for wedging cooperation with the reaction surface(s) said elements being locked in a clamped state.

15 Further features of the invention will appear from the dependent claims.

Other and further objects, features, and advantages will appear from the following disclosure of an embodiment of the  
20 invention which is preferred at present and is described to illustrate the invention without being limiting, and given with reference to the appended drawings, in which:

Figure 1 shows the finished joint according to the  
25 invention for joining structural elements;  
Figure 2 shows both structural elements according to Figure 1 before one is inserted into the other;  
Figure 3 is a sectional view through one of the structural elements, in which some critical angles  
30 are marked;  
Figure 4 is a sectional view through the joined structural elements with a diagrammatically shown punch press means;  
Figure 5 shows structural elements with a shape that  
35 differs from the shape shown in Figures 1-4; and  
Figure 6 shows the structural elements according to Figure 5 in a finished joint.



With reference to Figure 1, two different structural elements 5, 10 are shown, which are connected to form a finished joint 1. The basis of joint 1 is that one structural element 5 has a male portion 8 which is intended for insertion into a female portion 9 in the second structural element 10, as will appear from Figure 2. The structural element 10 has an engaging surface 3 which is intended for abutment against engaging surface 6 of the other structural element 5. Before the final joining of structural elements 5 and 10 it is necessary to ensure that engaging surfaces 3, 6 are in tight mutual abutment. As shown in Figure 2, the structural element 5 may in the shown embodiment consist of a cut-off length of an elongated extruded profile. In this manner the male portion 8 may obtain its desired shape in a simple manner and without secondary treatment. Thus grooves formed by surfaces 7 and 2 are, shaped immediately during continuous extrusion. In order to save weight and material, the male portion 8 may be formed with one or a plurality of voids 11. The structural element 10 may be an extruded standard profile, e.g. having a rectangular or square cross section and a suitable thickness. A square profile may be provided with rounded off internal and external corners. The internal corners may be recessed hollow keys. It should be understood that the cross sectional shape of male portion 8 perpendicular to the section of profile is complementary with the internal shape of structural element 10.

Figure 3 is a sectional view of a structural element 5, i. e. its section of profile. The longitudinal axis of the profile is designated A. In the intersection line of reaction surface 7 and surface 2 a normal N is orthogonal on axis A. The angle  $\alpha$  between surface 2 and the normal N may advantageously be in the range of  $45^{\circ}$  -  $80^{\circ}$ , and is preferably approximately  $70^{\circ}$ . Angle  $\beta$  between the reaction surface 7 and the normal N may advantageously be in the range of  $5^{\circ}$  -  $45^{\circ}$ , preferably it is approximately  $20^{\circ}$ .

Figure 4 shows a sectional view of the joined structural elements 5, 10 when inserted into a punch press means 15 comprising die block means 16, which are movable towards and away from structural elements 5, 10. Cutting and stamping punching tools 14 are mounted on the surface of blocks 16 facing the structural elements 5, 10. When the structural elements 5, 10 are correctly positioned in the press 15 the cutting and punching tools 14 are aligned with grooves formed by surfaces 2, 7 on the male portion 8. At the first contact with the female portion 9 of the structural element 10 the cutting and punching tools 14 will cut into and through the thickness of the profile and upset the cut out flaps or pressed-in portions 4 down into the groove which is defined by the surfaces 2 and 7. The flaps 4 which are cut out in the female portion 9 may be pressed into engagement with the inclined surface 2 on the male portion 8, although this is not a critical condition. At the same time the front face 12 of flap 4 will press towards the inclined reaction surface 7 on the male portion 8 which will provide a wedging effect between the structural elements 5, 10 which will cause the engaging surfaces 3 and 6, respectively to be further pressed against each other. In this manner a firm and stable connection is achieved between the structural elements 5 and 10. This connection or joint 1 will resist high compression forces in particular through the engaging surfaces 3 and 6, and simultaneously resist high tensile forces through the cooperating reaction surfaces 7 and 12.

Figures 5 and 6 show another embodiment of the joint according to the invention. Parts corresponding to the embodiment of Figures 1-4 are designated by the same reference numerals which are, however, marked. As will appear from Figure 5, the method and the joint for connecting structural elements of a plastic deformable material are used to join profiles of a substantially circular cross section. The structural element 5' has a male portion 8'

which is intended for insertion into the female portion 9' of the other structural element 10'. The structural element 5' is inserted into the structural element 10' to provide contact between the engaging surfaces 3' and 6' on respective structural elements. Upon insertion the structural elements 5', 10' are, as mentioned above, conveyed to a press (not shown) for punching out recessed members 4' and upsetting the same, preferably into contact with the surfaces 2' on the male portion 8' and to provide wedging cooperation between the reactions surfaces 7' and 12'. After joining the joint will be rigid as regards buckling due to the guiding of the male portion 8' inside the female portion 9'. The joint 1' will be able to resist both high compression forces and tensile forces.

It will appear from the above disclosure that the joint may be used to connect structural elements of variously shaped profiles, and it may be used for ordinary longitudinal extension, as indicated in Figures 5 and 6. Furthermore, it should be understood that any suitable cross sectional shape of the profile is possible, e.g. be triangular, square, hexagonal, or generally polygonal, elliptical, oval, or desired shape in addition to the shown rectangular and circular cross sectional shapes.

As mentioned, the invention was in particular developed for structural elements of aluminium, but it may, obviously be used with other materials which are plastic deformable, e.g. steel, copper, brass, and various alloys. It may also be used with materials of plastic, if desired with a subsequent hot-sealing operation.

It should also be understood that the number of recessed members may be from one, but is preferably two, or more. The longitudinal extent and width of the recessed members may obviously be adapted to the application of the structural members. If the structural members 5, 10 or joint 1 will be

subjected substantially to compression forces, the number of recessed members may be few, optionally said members may have a relatively small width. If the joint 1 is to be subjected substantially to tensile forces the number of recessed members 4 may be more, but the percentage of cut through area should not be higher than half of the total cross sectional area.

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## PATENT CLAIMS:

1.

A method for joining structural elements of a plastic deformable material, e.g. aluminium, with one structural element (5) having a male portion (8) with transversal groove surfaces (2, 7), which portion (8) is inserted into a female portion (9) of the other structural element (10), and said joining being carried out by means of a press means (15) so that discrete areas in form of flaps or recessed members (4) are cut out which members are upset down into said grooves, characterized in that said element (5) is brought into engagement with the other element (10), and said recessed members (4) on the female portion (9), upon upsetting is pressing their reaction surfaces (12) against at least one reaction surface (7) on said male portion (8), which is causing a wedging effect pulling the engaging surfaces (3, 6) of the elements into a firm and stable mutual engagement.

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2.

A method according to claim 1, characterized in that said recessed members (4) are upset all the way into contact with said surfaces (2) on said male portion (8).

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3.

A joint for connecting structural elements of a plastic deformable material, e.g. aluminium, with one structural element (5) having a male portion (8) with transversal groove surfaces (2, 7), which portion (8) is inserted into a female portion (9) of the other structural element (10), wherein discrete areas in the shape of flaps or recessed members (4) are upset into the grooves, characterized in that one structural element (5) has at least one engaging surface (6) and at least one reaction surface (7), and that the other structural element

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(10) has at least one engaging surface (3) for engagement with the engaging surface (6) of the first mentioned structural element, and that the recessed member (4) has a reaction surface (12) for wedging cooperation with said reaction surface(s) (7), said elements (5, 10) being locked in a stable clamped state.

4.

A joint according to claim 3,  
c h a r a c t e r i z e d i n that said recessed member (4) is substantially in fully engagement with the surfaces (2) of male the portion (8).

5.

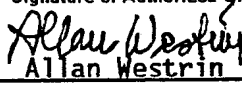
A joint according to claims 3 and 4,  
c h a r a c t e r i z e d i n that an angle  $\alpha$  between the surface (2) and a normal (N) standing orthogonally on the longitudinal axis (A) of the structural element (5) is between  $45^{\circ}$  and  $80^{\circ}$ , and preferably is approximately  $70^{\circ}$ .

6.

A joint according to claims 1-5,  
c h a r a c t e r i z e d i n that the angle  $\beta$  between the reaction surface (7) and the normal (N) is between  $5^{\circ}$  and  $45^{\circ}$ , and preferably approximately  $20^{\circ}$ .

# INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 91/00050

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC5: B 21 D 39/00, F 16 B 7/04		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC5	B 21 D; E 04 G; E 06 B; F 16 B; F 16 L	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched <sup>8</sup>		
SE,DK,FI,NO classes as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	DE, A, 2757886 (KLIMA + KÄLTE GMBH) 28 June 1979, see the whole document --	1-4
Y	US, A, 4192624 (CARLO G. BUCCI) 11 March 1980, see the whole document --	1-4
A		5-6
A	GB, A, 641986 (GENERAL BRONZE CORPORATION) 23 August 1950, see page 2, line 66 - line 111; figures 1-6 --	1-2,5-6
X		3-4
X	CH, A, 264274 (AKTIESELSKABET FISKER & NIELSEN) 3 January 1950, see page 2, line 76 - page 3, line 30; figure 6 --	3
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
17th June 1991	1991 -07- 0 1	
International Searching Authority	Signature of Authorized Officer	
SWEDISH PATENT OFFICE	 Allan Westrin	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US, A, 4072432 (PAUL M. LEVY) 7 February 1978, see column 5, line 25 - column 6, line 6; figures 1-7 --	3
A	DE, A, 2113026 (FA. HUBERT BUTTERWEGGE) 5 October 1972, see the whole document --	1-6
A	US, A, 599492 (EDWARD C. CARTER) 22 February 1898, see the whole document --	1-4
A	US, A, 2861659 (ANDREW T. HAGERTY ET AL) 25 November 1958, see the whole document --	1,3
A	CH, A, 648643 (GEORG FISCHER AKTIENGESELLSCHAFT) 29 March 1985, see the whole document --	1,3
A	GB, A, 1600912 (WAVIN B.V.) 21 October 1981, see the whole document -- -----	3



**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. PCT/NO 91/00050**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on **91-05-29**. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2757886	79-06-28	AT-B- 365957	82-02-25
US-A- 4192624	80-03-11	CA-A- 1081050	80-07-08
		US-A- 4336645	82-06-23
GB-A- 641986	50-08-23	NONE	
CH-A- 264274	50-01-03	DE-C- 945049	00-00-00
		GB-A- 621254	00-00-00
		NL-C- 69449	00-00-00
US-A- 4072432	78-02-07	NONE	
DE-A- 2113026	72-10-05	NONE	
US-A- 2861659	58-11-25	NONE	
CH-A- 648643	85-03-29	NONE	
GB-A- 1600912	81-10-21	DE-A-B-C 2819359	78-11-09
		FR-A- 2389823	78-12-01
		JP-A- 53140622	78-12-07
		NL-A- 7704927	78-11-07